

CLAIMS

What is claimed is:

1. An apparatus to detect substrate movement comprising an articulated robot arm for drawing or writing secured to a base and an image sensor.
2. The apparatus of claim 1, wherein the articulated robot arm comprises a plurality of software-controlled mechanical actuators and sensors.
3. The apparatus of claim 1, wherein the articulated robot arm is capable of picking up and holding an automatically controlled writing implement.
4. The apparatus of claim 1, wherein the image sensor is a digital video camera that provides video to a controller.
5. The apparatus of claim 4, wherein the digital video camera is attached to the articulated robot arm.
6. The controller of claim 4, wherein the controller is located within the articulated robot arm or base.
7. The controller of claim 4, wherein the controller is located within a separate computer and interfaced to the apparatus.
8. The controller of claim 4, wherein parts of the controller are located within the articulated robot arm or base and parts of the controller are located in a separate computer.
9. A method to detect substrate movement, the method comprising:
detecting with an image sensor that a substrate is blank;
drawing a specialized target on the substrate; and
using the image sensor to find and recognize the target.

10. The method of claim 9, wherein the image sensor is placed in a position where it can observe the substrate while a user is marking the substrate.

5 11. The method of claim 10, wherein the image sensor searches for the target in a plurality of video frames.

12. The method of claim 11, wherein a determination as to whether the substrate moved is made.

10 13. The method of claim 12, wherein the relative positions of the target and a drawing on the substrate are remembered, and this information is used to locate the drawing in the video frame is located relative to the target.

14. The method of claim 13, wherein the drawing in the video frame is examined for determining whether the user marked the substrate.

15. The method of claim 14, wherein a subsequent drawing is made by using the position of the target to find the location of the substrate suitable for drawing.

16. The method of claim 14, wherein the steps of searching for the target in a plurality of video frames, determining whether the substrate moved, locating the drawing in the video frame relative to the target, and examining the drawing in the video frame are repeated until a determination that the user marked the substrate is made.

25 17. The method of claim 15, wherein the process beginning with allowing the user to mark the substrate is repeated.

30 18. The method of claim 9, wherein the image sensor is a digital video camera.

19. The method of claim 9, wherein a controller draws the specialized target on the substrate.

20. The method of claim 9, wherein the target is asymmetrical to enable the controller to determine the orientation and position of the substrate.

21. A computer readable medium having computer readable instructions encoded thereon for:

drawing a specialized target on a blank substrate;

receiving video data from a digital video camera; and

performing a frame-by-frame analysis on the data to detect the presence of the specialized target.

22. The computer readable medium of claim 21 wherein the orientation and the position of the substrate is determined.

23. The computer readable medium of claim 22 wherein a search for the target is performed in a plurality of video frames.

24. The computer readable medium of claim 23 wherein a frame-by-frame analysis is performed on the data to detect the presence of drawings or writings in a video frame relative to the target.

25. The computer readable medium of claim 24 wherein the drawing or writing in the video frame is examined for determining whether a user marked the substrate.

26. The computer readable medium of claim 25 wherein a subsequent drawing is made by using the position of the target to find the location of the substrate suitable for drawing.

27. The computer readable medium of claim 25, wherein the steps of searching for the target in a plurality of video frames, locating the drawing in the video frame relative to the target, and examining the drawing in the video frame are repeated until a determination that the user marked the substrate is made.

28. The computer readable medium of claim 26, wherein the process beginning with allowing the user to mark the substrate is repeated.

29. The computer readable medium of claim 21, wherein the articulated robot arm comprises a plurality of software-controlled mechanical actuators and sensors.

30. The computer readable medium of claim 21, wherein the specialized target is asymmetrical.

31. The computer readable medium of claim 21, the computer readable medium further including computer readable instructions encoded thereon for remembering the relative positions of the target and drawings on the substrate.

32. An apparatus comprising:

an articulated robot arm for drawing a specialized target on a substrate and for drawing or writing secured to a base;

an image sensor for finding and recognizing the target; and

a controller, having a storage medium, including a rule set to interact with a user and instructions to manipulate the robot arm,

to receive and process an image from the image sensor;

to determine an action based on the rule set and the image; and

to move the robot arm based on a determination of the image based on the rule set.

33. The apparatus of claim 32, wherein the specialized target is asymmetrical.

34. The apparatus of claim 32, wherein the relative positions of the target and a drawing on the substrate are remembered, and this information is used to locate the drawing in the video frame relative to the target.

5 35. The apparatus of claim 32, wherein the robot arm comprises a plurality of software-controlled mechanical actuators and sensors.

36. The apparatus of claim 32, wherein the image sensor is a digital video camera that provides video to the controller.

10